A Global Strategy
for the conservation and use of Coconut Genetic Resources
2018-2028

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LA RECHERCHE AGRONOMIQUE
POUR LE DÉVELOPPEMENT

COGENT
Coconut genetic resources for enhanced livelihoods

Bioversity International

Studies have been conducted on the gene sequence, regulation pattern and expression of various genes involved in fatty acid metabolism during *in vitro* culture, as well as in the Makapuno trait and in disease resistance. Single nucleotide-amplified polymorphism SNAP markers linked to enzymes involved in endosperm development were shown to be polymorphic when comparing Makapuno/Kopyor and normal coconut (Sukendahm et al. 2009). Markers associated with the Tall-type palm trait in coconut were identified using either sequence-characterized amplification region (SCAR) (Rajesh et al. 2013) or SSR (Bandupriya et al. 2013) markers The genomes of key coconut pathogens (Phytoplasma, Eriophyes) has also been studied.

Apart from SSR markers, expressed sequence tag (EST)-derived single nucleotide polymorphism (SNP) and insertion-deletion polymorphism (indel) markers also been applied in coconut genomics research. Coconut WRKY transcription factor genes were used to assess variation at the single nucleotide level, and SNPs were detected. Recently, an extensive transcriptome sequencing campaign has allowed identifying 57,304 unique genes (Fan et al. 2013) and the complete chloroplast genome has been obtained (Huang et al. 2013). Thus, the genomics and information revolution has generated a wealth of information which is now beginning to be used for breeding purposes.

2.5.9 Coconut, climate change and coastal areas

Many studies have shown that global warming is a key likely threat to future biodiversity. The impact of climate change on crop cultivation is assessed via controlled environment experiments and/or simulation models. For perennial crops, field experiments are expensive and time consuming. However, they provide crucial information for model inputs which are then used for wider applications. Such predictive simulations are important for alerting scientists, decision-makers and other stakeholders. They support the development of proactive strategies to reduce climate change impacts on biodiversity, food security and livelihoods (Bellard et al. 2012). For instance, location-specific management of coconut plantations can double yields in many regions of India.

Although rise in sea level is one of the most certain consequences of global warming, it remains one of the least studied. Several simulations state that rises in sea level will accelerate in future with a potential rise from 0.5 to 0.98m by the end of the century (IPCC 2013[50]). Globally, around 180,000 islands (Bellard et al. 2012) enclose a fifth of

In 2016, Bioversity embarked on a UK Darwin Initiative[1]-This genebank is being transferred to a safe site in PNG, to avoid phytoplasma infection. The project is identifying, mapping and collecting unconserved coconut diversity that is threatened by predicted climate change, in Fiji, PNG and Samoa. This diversity will be conserved in a new ICG-SP embracing the three countries.

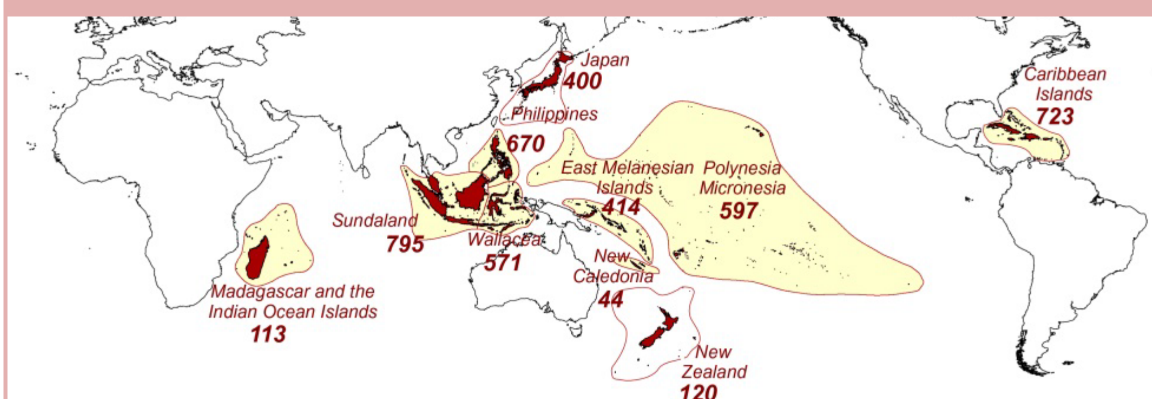
[50] See the URL: http://www.ipcc.ch/report/ar5/wg1/ More details about sea level change in Chapter 13 of the report at URL: https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter13_FINAL.pdf

the world's biodiversity) (Kier et al. 2009) and certainly more than 50% of coconut diversity. At least two thirds of coconut plantations are located in coastal zones and the majority of coconut growing countries are islands.

Effects of climate change are already obvious. For example, on some Polynesian islands in the Tuamotu Archipelago, coconut farmers point out increasingly frequent phenomena of high tidal swell and saltwater incursions from the ocean on atolls. This phenomenon is not new but this swell sweeps fallen coconuts off the strands and salt water stays longer on the land and contributes to a high salinization of soils and the fresh-water lens on atolls, inducing a decrease in coconut production (Prades and Ollivier 2013).

Recently, a study was conducted on 10 insular biodiversity hotspots (Bellard et al. 2014), eight of which are spread over 3927 islands, which include important coconut cultivation areas (Figure 2.8). Depending on the sea level rise scenario, the number of "coconut" islands with submersion risk ranges from 231 to 700 (Table 2.7). Therefore, priorities for collecting the most endangered germplasm are to be set by integrating these projections from climate scenarios, the knowledge on *in situ* coconut diversity and the analysis of the diversity presently conserved in *ex situ* collections.

Figure. 2.8. Localization of the eight insular biodiversity hotspots (in red) which includes important coconut cultivation areas (in pale yellow). Adapted from Bellard et al. 2012.



In addition to sea level rise, climate change is projected to increase mean temperatures, accentuate skewed precipitation, and increase the frequency and intensity of extreme rainfall events and tropical cyclones, leading to more frequent flooding. Apart from low altitude islands, the cultivation zones most endangered by climate changes will be the river deltas and the zones prone to longer dry or hot periods. Some models project a substantial decline in winter rainfall in South-east Asia.

Growing more resilient varieties is essential for regions that are projected to be negatively impacted by climate change. 'Climate resilient' coconut varieties possessing characteristics such as: stronger root systems, thicker and shorter stems for tolerance to cyclones; drought tolerance for regions affected by longer dry seasons; and tolerance to greater heat (Ranasinghe et al. 2012) and more saline environments, when appropriate.

Plate 2.3

Coconut, climate change and coastal area

Coconut is much more than coconut!

At least two thirds of coconut plantations are located in coastal zones. Coconut palms could be more extensively used to mitigate coastal erosion and protect villagers against weather hazards.

1 & 2. A coral island in Funafuti Archipelago, Tuvalu, Micronesia, and the area of its beach most exposed to storms and cyclones.

3. A coconut crab from the same island.

4. A village beach in Funafuti Archipelago, one of the areas most threatened by sea level rise in Tuvalu.

5. View of typical vegetation of small coral islands in Micronesia. Increasingly frequent high tidal swells and saltwater incursions from the ocean contribute to a high salinization of soils and the fresh-water lens on atolls.

6. Extreme erosion along Quelimane river in Mozambique.

7. Soil erosion near a river delta in Moheli Island, Comoro archipelago. Planting the coconut palms more densely would probably have better protected the soil.

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Table 2.8. Projected numbers of islands to be submerged by the sea - under two scenarios: A - Rise in sea level by 1 m and B - by 6 m (From Bellard et al. 2012).

Hotspots	Total	Scenario A	Scenario B
Madagascar & Indian Ocean	113	4	13
Sundaland	795	61	122
Walacea	571	39	7
New Caledonia	44	1	5
East Melanesia-Polynesia	597	15	84
Philippines	670	48	113
Caribbean Islands	723	63	356
Total	3 513	231	700

By 2030, 50% of the world population will live within 100 km of the coast (Bindo et al. 2007) and hence inside coconut cultivation areas in tropical countries. Coconut tolerates moderate salinity and is the most adapted crop to sandy coastal areas. In India, the CPCRI has developed a coconut-based technology for littoral sandy soil management by adopting soil-moisture conservation measures and resorting to intercropping. The technique converts hot sandy stretches of land into highly productive and remunerative cropping systems. It involves moisture conservation with coconut husk and coir pith, and intercropping during the wet season with a variety of vegetables, pineapple and fodder grass. This system enables farmers to double their income and has potential for wider application.

Interactions between coconut and climate occur in two main ways. While climate change influences coconut plantations, the climate itself is also moderated by the plantations. Coconut plantations are very good candidates for mitigating greenhouse gas emissions. Depending on their extent of spread, coconut plantations contribute to microclimates which regulate the weather and allow intercropping. Coconut plantations capture carbon dioxide and release oxygen, as for any photosynthesising plant. The carbon sequestration potential of coconut plantations is estimated to be about 8-32 Mg CO_2/ha/year depending on the age, soil type and management as well as the components considered (Kumar 2009, Roupsard et al. 2002). Apart from these, coconut oil is also used as fuel oil in remote islands where the cost of imported fuel transportation is high, as well as in

Palms for Tsunami survival

People of the Pacific Region traditionally used coconut palm to survive a tsunami or cyclones: for instance in the Tuamotu Archipelago, the Polynesian practice to survive tsunamis was the following: when isolated on a low coral island, quickly climb a tall coconut palm, cut off all its leaves, and attach yourself with a rope to the top of the trunk, and wait...

some bigger islands such as those of the Philippines. Utilization of coconut biomass residues such as shells and husks for heat and power generation is common in the coconut and allied industries.

Although coconut palms are widely planted in coastal zones to reduce erosion, no scientific study has yet been conducted to assess, quantify and eventually promote this use. When used for beach landscaping, these palms tolerate flooding better than *Casuarina* trees (filao). For instance, coconut palms played a crucial role during the 2004 tsunami and saved hundreds of lives by reducing the intensity of wave. In many coastal villages, coconut palms remained standing even when many houses and other buildings were flattened.

2.5.10 Coconut conservation, landscapes and ecotourism

In 2015, more than 1.2 billion international tourist arrivals were counted worldwide[51]. For a long time, tourism has been associated with sea, sand and sun, often referred to as the 3Ss. Local and international tourism is significantly associated with coastal environments. Coconut palms have long been associated with the natural aesthetics of tropical tourist destinations.

Ecotourism can potentially provide important economic benefits to local people and help protect biodiversity. Community-based ecotourism has become a popular tool for biodiversity conservation and sustainably boosting livelihoods; based on the principle that biodiversity must pay for itself by generating economic benefits, particularly for local people. Local stakeholders and international companies involved in tourism can be convinced to develop ecotourism programmes favouring coconut genetic resources conservation. For the tourism industry evolving in a competitive environment, it becomes more and more important to stand out from the standard fare that tourism offers. Coconut palms should not symbolize anonymous exoticism. They can tell true stories, specifically related to local cultures, and they could be used in the framework of an ecotourism and anthropotourism approach.

In addition to the beauty of standing coconut palms, there is a wide range of possibilities to use coconut for tourism and ecotourism activities. The concept of a coconut park (Coconut World) was elaborated in Australia to harness the potential of coconut for ecotourism, linked with education, research and genetic conservation (Samosir et al. 2006).

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51 See URL: http://data.worldbank.org/indicator/ST.INT.ARVL